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贵州兴义中三叠世 Nothosaurus 一新种[1)]

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摘要: 记述了贵州兴义法郎组竹竿坡段幻龙一新种 ——*Nothosaurus youngi* sp. nov.。新种以眶后弓窄,上颌骨和眶后骨在轭骨之后相连,外翼骨形成明显的腹向凸缘,下颌具清晰的冠状突,和夹板骨前端进入下颌缝合部等特征区别于幻龙的其他种。支序分析的结果表明 *N. youngi* 的原始性仅次于 *N. juvenilis*。新种 *N. youngi* 具有 *Nothosaurus* 中的一些原始特征,短的下颌缝合部,短的上颌齿列和窄的眶后弓,新种在法郎组竹杆坡段的发现支持含化石地层为中三叠世拉丁期的结论。

关键词: 贵州兴义,中三叠世,幻龙

中图法分类号: Q915.864 **文献标识码**: A **文章编号**: 1000 - 3118(2004)01 - 0001 - 12

贵州兴义顶效因产出第一个中国三叠纪海生爬行类动物 ——胡氏贵州龙(*Keichousaurus hui* Young, 1958)而闻名。化石产自法郎组竹杆坡段。1965 年杨钟健先生记述了发现于同一层位、同一地点的幻龙亚目扁鼻龙科的意外兴义龙(Nothosauria, Simosauridae, *Shingyisaurus unexpectus*)。Rieppel(1998)对意外兴义龙化石材料进行了重新研究,依据锥状的牙齿,明显收缩的顶骨平台,后置的松果孔,水平暴露的三角形的上枕骨和膨胀于颌关节之下的上隅骨将其修订为幻龙的未定种(*Nothosaurus* sp.)。Rieppel(2000)又进一步认为这一化石材料在可归入 *Nothosaurus* 的同时,存在归入另一密切相关属的可能性。

幻龙属主要分布于西特提斯区(包括欧洲、西亚和北非等地)的下安尼阶至上拉丁阶,个别种(如 *N. edingerae* Schultze, 1970)可达下卡尼阶。Rieppel(2000)在编写鳍龙类的百科全书时确认了该属 8 个有效种,它们是 *N. mirabilis* Münster, 1834, *N. cymatosauroides* Sanz, 1983, *N. edingerae* Schultze, 1970, *N. giganteus* Münster, 1834, *N. haasi* Rieppel et al., 1997, *N. juvenilis* Edinger, 1921, *N. marchicus* Koken, 1893 和 *N. tchernovi* Haas, 1980。2001 年他又记述了发现于德国壳灰岩(Muschelkalk)上部的幻龙一新种 *N. jagisteus*。前述发现于贵州顶效的 *Nothosaurus* sp. 化石,仅包括一扭曲的不完整头骨和 5 节前部颈椎(中国地质博物馆 NGMC Vm 1308)。材料虽不完整但它却是中国发现的第一个幻龙属的代表。自 20 世纪 90 年代以来,在贵州兴义及相邻地区的法郎组竹杆坡段陆续有一些幻龙类的骨架被发现。本文记述了 2001 年野外工作期间获得的幻龙一新材料。

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幻龙属 Nothosaurus **Münster, 1834**

杨氏幻龙(新种) Nothosaurus youngi **sp. nov.**

(图 1～3)

释名 种名献给中国古脊椎动物研究的奠基人及中国三叠纪海生爬行动物研究的开创者已故杨钟健院士(1897～1979)。

正模 一近于完整的头骨、下颌及不完整的头后骨架(古脊椎动物与古人类研究所,IVPP V 13590)。

产地及层位 贵州兴义,中三叠统法郎组竹杆坡段。

特征 幻龙属一小型的种(头骨中线长度 160mm);吻部适度发育,吻端钝圆,后部有明显的收缩;具 5 个呈匍匐状的前颌骨獠齿和 4 个弯曲向上的下颌缝合部獠齿;细条状的轭骨前端未伸达眼眶边缘,上颌骨和眶后骨在轭骨之后相接;眶后弓窄;外翼骨形成明显的腹向凸缘;下颌具清晰的冠状突,夹板骨前端进入下颌缝合部;腕骨 4 块。

描述 见英文部分。

对比与讨论 在众多的 *Nothosaurus* 种中,*N. giganteus* 大型,仅具 4 个前颌骨獠齿(fangs);*N. mirabilis* 的头长 460mm,吻部细长,上颌齿列可伸达上颞孔中点;*N. tchernovi* 的头骨中等大小,细长吻部的两侧近于平行,轭骨缺失;依据这些特征它们都明显地区别于 V 13590。在 *Nothosaurus* 小型的种中,它们以下列的特征有别于 V 13590:*N. edingerae* 的松果孔之后具矢状脊,前颌骨后突伸达外鼻孔后缘之后;*N. juvanilis* 翼骨强烈前伸,非常靠近内鼻孔,下颌关节的位置比枕髁更靠后;*N. haasi* 吻部细长,前颌骨与额骨相接,前额骨和轭骨缺失,上颞孔小;*N. jagisteus* 的吻部细长,两侧边近于平行,上颌齿列后端可延至上颞孔的 1/3～2/3。在头骨大小和形状上与 V 13590 最为相似的是发现于德国柏林附近 Rudersdorf 中三叠统 Karlstadt 组的 *N. marchicus*。

N. youngi 与 *N. marchicus* 一样属小型幻龙类,二者在头骨形态及各部比例上极为相似。*N. youngi* 也有相对短而宽的吻部,吻端 - 眼眶前缘与吻端 - 外鼻孔前缘之比为1.9,吻端 - 上颞孔前缘与吻端 - 外鼻孔前缘之比为 3.0,外鼻孔长与宽之比为 1.5,它们分别落在 *N. marchicus* 中与之对应的数据——1.8～2.0, 2.9～3.4 和 1.0～1.4(1.6)——范围之内(Rieppel and Wild, 1996)。二者之间的区别体现在一些具体的结构特征上,如 *N. marchicus* 的鉴定特征中包括,在一对上颌骨獠齿之前有 5 个小的上颌骨齿,但在 *N. youngi* 中仅有 4 个小齿;*N. marchicus* 的外翼骨前伸至腭部的 1/2 处,*N. youngi* 的外翼骨短小,没有特殊的前伸的迹象。二者都有较短的上颌齿列,但比较起来 *N. youngi* 的更短一些,它未达上颞孔的 1/4 处。上颞孔长与上颞孔前端 - 上颌骨后端长度之比为 6.1,大大超过 *N. marchicus* 中相应的值 3.4～3.6 (Rieppel and Wild, 1996)。*N. youngi* 与 *N. marchicus* 的鼻骨形态相似,都为宽的叶片状,表面具放射状纹饰。*N. youngi* 中鼻骨后侧方与后额骨相连,阻隔了额骨与上颌骨。而 *N. marchicus* 中的鼻骨受额骨与上颌骨的阻隔,不与前额骨相连。*N. youngi* 的夹板骨前端进入了上颌缝合部,这在幻龙类中是独特的。*N. youngi* 的另一个独有的特征是它的下颌上有小的喙状突。这两个特殊的结构不仅未发现于其他的幻龙中,亦未见于 *Simosaurus* (Rieppel, 1994)。

除杨氏幻龙外,发现于贵州兴义法郎组竹杆坡段的幻龙科成员还有幻龙未定种和兴

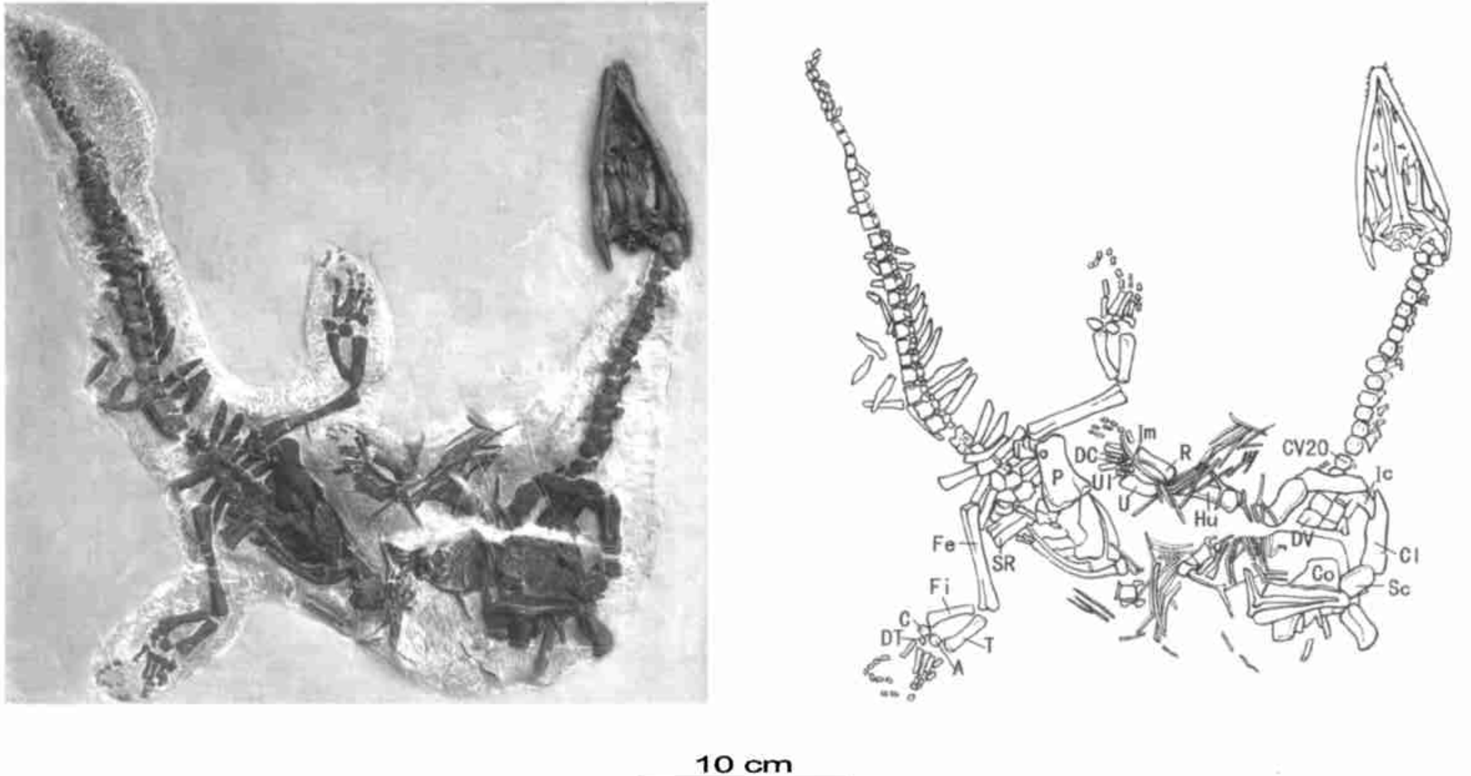


图1 杨氏幻龙(新种)骨架(IVPP V 13590)

Fig.1 Skeleton of *Nothosaurus youngi* sp. nov. (IVPP V 13590)

简字说明 Abbreviations: A. Astragalus 距骨; C. Calcanium 跟骨; Cl. Clavical 锁骨; Co. Coracoid 乌喙骨; CV20. The 20th Cervical Vertebra 第 20 节颈椎; DC. Distal Carpals 远端腕骨; DT. Distal Tarsal 远端跗骨; DV. Dorsal Vertebra 背椎; Fe. Femur 股骨; Fi. Fibula 腓骨; Hu. Humerus 肱骨; I. Ilium 肠骨; Ic. Interclavical 间锁骨; Im. Intermedium 中间腕骨; P. Pubis 耻骨; R. Radius 桡骨; Sc. Scapula 肩胛骨; SR. Sacral Rib 荐肋; T. Tibia 胫骨; U. Ulna 尺骨; Ul. Ulnare 尺腕骨

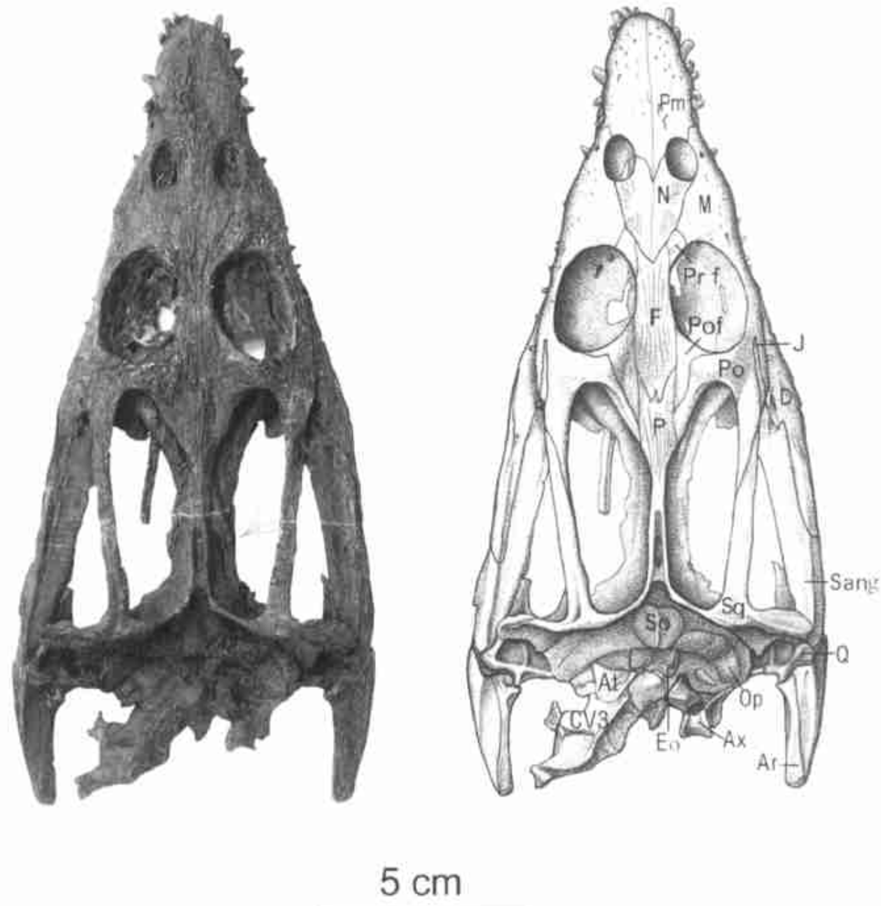


图 2 杨氏幻龙(新种)头骨和下颌(IVPP V 13590)顶视

Fig. 2 Skull and lower jaws of *Nothosaurus youngi* sp. nov. (IVPP V 13590) in dorsal view

简字说明 Abbreviations:Ar. Articular **关节骨**; At. Atlas **环椎**; Ax. Axis **枢椎**; CV3. The 3rd Cervical Vertebra **第 3 节颈椎**; D. Dentary **齿骨**; Eo. Exoccipital **外翼骨**; F. Frontal **额骨**; J. Jugal **轭骨**; M. Maxilla **上颌骨**; N. Nasal **鼻骨**; Op. Opisthotic **后耳骨**; P. Parietal **顶骨**; Pm. Premaxilla **前颌骨**; Po. Postorbital **眶后骨**; Pof. Postfrontal **后额骨**; Prf. Prefrontal **前额骨**; Q. Quadrate **方骨**; Sang. Surangular **上隅骨**; So. Supraoccipital **上枕骨**; Sq. Squamosal **鳞骨**

义鸥龙(*Lariosaurus xingyiensis*)(李锦玲等,2002;Rieppel et al., 2003)。如前所述 *Nothosaurus* sp. (NGMC Vm 1308)系意外兴义龙(*Shingyisaurus unexpectus* Young, 1965)的修订名称,化石材料包括一不完整的头骨和 5 个前部颈椎。因 NGMC Vm 1308 保存的不完整性及头骨的强烈扭曲,二者间很难进行全面的比较。可以辨识的区别包括 Vm 1308 的额骨 - 顶骨骨缝位于上颞孔前端之后的 2/5 处,比 *N. youngi* 中的骨缝要更靠后;从保存较好的头骨左侧来看眼眶与上颞孔之间的距离相对较宽,它大于外鼻孔与眼眶之间的距离的 1/2。目前尚未发现充足的理由将它们归入 *Nothosaurus* 的同一种。兴义鸥龙的头骨与欧洲产

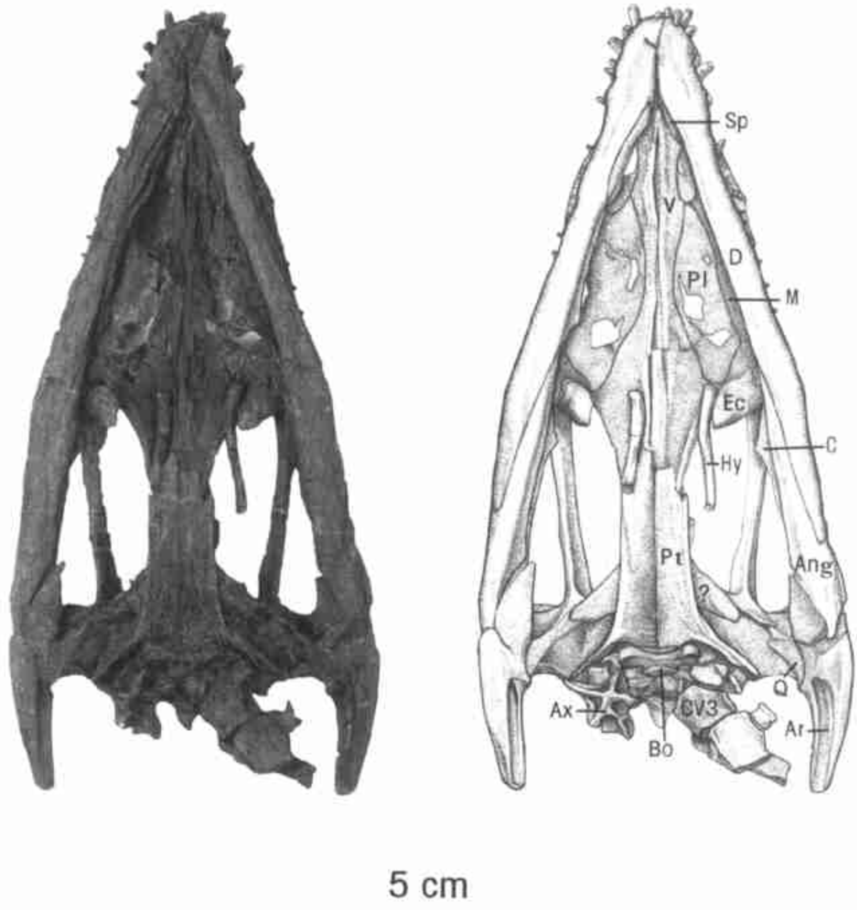


图 3　杨氏幻龙(新种)头骨和下颌(IVPP V 13590)腹视

Fig. 3　Skull and lower jaws of *Nothosaurus youngi* sp. nov. (IVPP V 13590) in ventral view

简字说明 Abbreviations: Ang. Angular 隅骨; Ar. Articular 关节骨; Ax. Axis 枢椎; Bo. Basioccipital 基枕骨; C. Coronoid 冠状骨; CV3. The 3rd Cervical Vertebra 第 3 节颈椎; D. Dentary 齿骨; Ec. Ectopterygoid 外翼骨; Hy. Hyobranchium 舌鳃骨; M. Maxilla 上颌骨; Pl. Palatine 腭骨; Pt. Pterygoid 翼骨; Q. Quadrate 方骨; Sp. Splenial 夹板骨; V. Vomer 锄骨

Lariosaurus 的头骨在顶骨平台(parietal skull table)的形状上有较大差别,而与 *Nothosaurus* 的头骨更为相似。它与 *N. youngi* 同属小型幻龙类,头骨的形状也很相似。特别是兴义鸥龙也有非常窄的眼眶-上颞孔间距离。二者的区别在于:*Lariosaurus xingyiensis* 的顶孔位于顶骨的后 1/3 处,顶孔之后形成一窄的顶脊,而 *N. youngi* 的顶孔位于一深凹中,在顶孔之后未见矢状脊;*L. xingyiensis* 中额骨-顶骨骨缝比 *N. youngi* 的要更靠后;*L. xingyiensis* 的鼻骨被前颌骨的背突排除出外鼻孔的内缘,而 *N. youngi* 的鼻骨有一前突沿外鼻孔的内侧缘向前延伸。二者之间在头后骨骼的结构上区别是明显的。

Rieppel 等(1999)选取了 25 个性状,对 Pachypleurosauroidea、*Simosaurus* 和幻龙属的 8

个种(包括一个未描述的 Winterswijk 的材料)进行了分支系统分析,获得了一个最简约的树(TL = 62,CI = 0.677, RI = 0.661)。幻龙属内的亲缘关系在这一分析中得到了解决。2001 年 Rieppel 对 25 个形状中的 2 个稍作调整,加入了新订立的种 *Nothosaurus jagisteus* 进行分析,得到一个与 1999 年结果十分相似的最简约的树(TL = 65, CI = 0.662, RI = 0.651)。在这两次分析中虽然幻龙属的单系性质得到证实,但幻龙属各种在支序图上排列的顺序与它们在地层中出现的先后并不完全相符。

此次将 V 13590 的性状加入 Rieppel (2001) 的矩阵(见表 3),应用 PAUP Version 4.0b10 进行分析。计算时所有性状均为"无序"和"等权"处理,以 Pachypleurosauroidea、*Simosaurus* 和 *Germanosaurus* 为外类群,用 Branch-and-Bound 方式搜索,得到 12 个最简约的分支树及它们的严格合意树(图 5)。其中第 7 个最简约的分支树(图 4)与 Rieppel (2001) 最简约的树极为相似。在所有 12 个最简约树中新种都作为除 *N. juvenilis* 之外的所有 *Nothosaurus* 种的姐妹群。*Nothosaurus* 属征(节点 23～22)的性状与 Rieppel (2001) 分析结果相同,同样是 4(1), 5(1), 19(1), 21(1), 22(2), 23(2) 和 24(1)。新种与除 *N. juvenilis* 之外的其他幻龙种的共近裔性状是:10(1) 后额骨未进入上颞孔的边缘;12(1) 眶后骨占据全部的上颞孔前缘;以及 18(1) 上颞孔的前部因顶骨的侧向突出而收缩。虽然此次分析又一次确认了 *Nothosaurus* 的单系性,但在得到的严格合意树中 *N. gigantius*, *N. mirabilis*, *N. jagisteus* (*N. haasi*, *N. tchernovi*) 之间的关系,及它们与 *N. edingerae*, *N. marchicus*, Winterswijk 之间的关系是无解的。分析证实了贵州兴义的杨氏幻龙的原始性仅次于 *N. juvenilis*。

前已述及,幻龙属主要分布于西特提斯区的中三叠统,只有 *N. edingerae* 的一些材料发现于上三叠统的卡尼阶。与 *N. youngi* 关系密切的 *N. marchicus* 分布于欧洲的安尼阶至拉丁阶。幻龙新种 *N. youngi* 具有 *Nothosaurus* 中的一些原始特征,短的下颌缝合部,短的上颌齿列和窄的眶后弓,新种在法郎组竹杆坡段的发现支持含化石地层为拉丁期的结论(杨钟健,1958;陈宗富,1985;李锦玲等,2002)。

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A NEW NOTHOSAUR FROM MIDDLE TRIASSIC OF GUIZHOU, CHINA

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Key words Xingyi, Guizhou, Middle Triassic, Nothosauridae

According to Rieppel (2000), the genus *Nothosaurus* contains 8 valid species (*N. mirabilis*, *N. cymatosauroides*, *N. edingerae*, *N. haasi*, *N. giganteus*, *N. juvenilis*, *N. marchicus*, *N. tchernovi*), which were all found in deposits ranging from the lower Anisian to the lower Carnian of the Western Tethyian faunal province (Europe, northern Africa and western Asia). More recently, a new species, *N. jagisteus*, was described by Rieppel (2001) based on a partial skeleton from upper Muschelkalk of southern Germany.

The first representative of the genus *Nothosaurus* in the Eastern Tethyian faunal province is *Nothosaurus* sp. (Rieppel, 1998), represented by a seriously damaged skull and 5 cervical vertebrae (National Geological Museum of China Vm 1308), and previously recognized as a simosaur *Shingyisaurus unexpectus* by Young C C in 1965. Since the 1990s, many nothosaur specimens have been discovered from the Zhuganpo Member of the Falang Formation in Xingyi, Guizhou and in adjacent areas. The material described in the present paper was collected during the field season of 2001.

Sauropterygia Owen, 1860
Nothosauria Seeley, 1882
Nothosauridae Baur, 1889
Nothosaurus **Münster, 1834**
Nothosaurus youngi **sp. nov.**
(Figs. 1～3)

Etymology Named in honor of the founder of Chinese vertebrate paleontology and the pioneer of Chinese Triassic marine reptile study, late Academician Chung-chien Young.

Holotype A nearly complete skull, lower jaws and incomplete postcranial skeleton (IVPP V 13590).

Locality and horizon Xingyi, Guizhou; Zhuganpo Member, Falang Formation, Middle Triassic.

Diagnosis A small sized species of *Nothosaurus* with skull condylobasal length 160mm; 5 large procumbent fangs present on premaxilla and 4 curved fangs on mandibular symphysis; jugal narrow and splint like with its anterior end excluded from orbit, and postorbital and maxilla in contact behind jugal; distinct and well developed ventrally projecting ectopterygoid flanges present; lower jaw bearing an obvious coronoid process; splenial entering the mandibular symphysis; 4 carpal ossifications.

Description The specimen IVPP V 13590 is exposed on its ventral side. It is an incomplete skeleton, with the palatal surface of skull, manus, pes and gastralia broken, the left anterior limb lost, and the dorsal vertebrae and ribs embedded in matrix. The skull was flattened during fossilization, but its dorsal surface is perfectly preserved. The skull is similar to that of *Nothosaurus marchicus* in contour and size. The snout is short and blunt, with a weakly developed rostral constriction. Both the external naris and orbit are short and wide. The elongate upper temporal fenestra is constricted at the anterior corner. Its longitudinal dimension is uwo times as that of the orbit. The ratio of skull length to width (divide the distance of anterior end of snout-occipital condyle by skull width at postorbital) is 2.75, smaller than the corresponding ratio in *N. mirabilis* (3.97～4.08) and in *N. giganteus* (3.32) (measurements from Rieppel and Wild, 1996, Fig. 58 and Fig. 10).

The premaxilla forming the rostrum contacts the maxilla at the anterolateral corner of the external naris. The posterior process of the premaxilla extends backward between the external nares to meet the nasal at the level of the posterior end of the external naris. Its surface is sculptured with small and scattered pits. Five premaxillary fangs are variously preserved on left and right side. The 1st right premaxillary tooth is lost, represented by a large alveolus. The 3rd is the stoutest fang and the 4th and 5th are reduced successively in size on the right side. The 1st, 3rd and 5th fangs are comparatively small, but the 2nd is large and the 4th is the strongest on the left side.

The nasal is a large and leaf-shaped element. It meets its counterpart along the midline, separating the premaxilla from the frontal. A short and slender anterior process of the nasal extends forward to the middle point of the medial margin of the external naris as is also the case in *N. haasi*, in contrast to the processes reaching to the anterior end of the external naris in *N. juvenilis*, *N. giganteus* and *N. mirabilis*. The nasal contacts the maxilla, prefrontal and frontal laterally. The surface of the bone is decorated with a distinct radiating pattern of grooves and ridges.

The frontal is fused. Its anterolateral corner is separated from the maxilla by a contact of the nasal and prefrontal as in *N. juvenilis*, whereas, in *N. marchicus* and *N. jagisteus* the frontal contacts the maxilla. The lateral margin of the frontal is comparatively straight, a short distance of which enters the medial border of the orbit. The frontal extends posteriorly to meet the parietal in an interdigitating suture well behind the anterior end of the upper temporal fossa. There are many deep longitudinal grooves and ridges on the frontal.

The prefrontal is a small bone located between the maxilla, nasal and frontal. It occupies the anteromedial border of the orbit. The sculpturing of the surface of the bone is deep and stout.

The postfrontal defines the posteromedial border of the orbit, with a distinct postorbital constriction, and its posteriorly pointing apex is embraced between the postorbital and the parietal. The posterior end of the postfrontal reaches to a point behind the anterior end of the upper temporal fossa, but does not enter the margin of the fossa.

The parietal is elongate and unpaired. An elongated pineal foramen is located in a trough near the posterior end of the parietal. Before the pineal foramen the parietal narrows to a slender skull table, whereas a sagittal crest is behind the pineal foramen in *N. edingerae*. Posteriorly, the parietal is broadened, with a concave posterior margin. A well defined occipital crest separates the parietal skull table from the occipital exposure of the parietal.

The maxilla forms a significant part of the lateral margins of the external naries and the orbit, extending posteriorly from the antero-lateral corner of the external naris to a level behind the anterior end, but in front of 1/4 length of the upper temporal fossa. As in *N. marchicus*, *N. juvenilis*, *N. giganteus* and *N. mirabilis* there is a small depression on the maxilla lateral to the external naris, and a small foramen is present on the floor of the depression. The right maxillary dentition is almost completely preserved. One basal part of a crown with a large cross section, represents the first maxillary fang that is retained on the laterally buldging part of the maxilla between the external naris and the orbit. Following that a large alveolus indicates the presence of the second maxillary fang. There are 4 positions for smaller teeth (only the 3rd is preserved) in front of the fangs, but 16 (11 teeth preserved) behind the fangs.

The large postorbital forms part of the posterior margin of the orbit, and the anterior margin of the upper temporal fossa, with a posteromedial branch that is shorter than the posterolateral one, the latter reaching almost to the middle point of the upper temporal fossa. The postorbital arch formed by the postorbital is relatively narrower than that of other species of *Nothosaurus*. The distance orbit-external naris (15mm) divided by the distance orbit-upper temporal fossa (7mm) is 2.14, but around 1 in *N. marchicus*.

The jugal is a small and strap-shaped bone, located between the maxilla and postorbital. Its anterior end does not enter the margin of the orbit, and its posterior end seems to be embraced by the postorbital and the maxilla as in *N. jagisteus*, which shows only on the lateral view of the skull.

The squamosal is a triradiate element, with its anterior ramus contacting the postorbital at the mid-point of the temporal arch and the maxilla at a level anterior to 1/4 length of the upper temporal fossa. Posterolateral to the upper temporal fossa, the squamosal is drawn out into a distinct and long lateral ramus, which covers the upper end of the quadrate. On the occipital surface the squamosal meets the supraoccipital and the opisthotic.

The right quadrate is slightly broken, while the left one is completely preserved. The bone has a wide connection with the quadrate ramus of the pterygoid on the ventral view. The lateral condyle of the quadrate is larger than the medial one. They are situated in different horizontal and vertical levels —the lateral condyle is higher and anteriorer than the medial one.

The occiput is closed and plate like, but no posttemporal foramen and opening of cranioquadrate passage can be detected (perhaps due to dorsoventral compression of the skull). Because some anterior cervical vertebrae overlap the lower part of the occiput, the occipital condyle is only exposed on the ventral surface. It is located at the same level as the mandibular condyles of the quadrate.

The supraoccipital is a leave-shaped element that carries a distinct sagittal crest, which does not reach the anterior margin of the bone. The foramen magnum is obscured by the dislocated exoccipitals. The opisthotic is large, and its lateral margin seems not contact the quadrate.

The major features of the palate can be established, although some bones are crushed and its anterior portion is covered by the symphysis of articulated lower jaws. The exact shape of the vomer is difficult to determine, because it was deformed by some longitudinal grooves. But it does show evidence of forming the medial margin of the choana and contact the palatine laterally and the pterygoid posteriorly. The palatine is a quite large, thin bone that forms the posterior margin of the choana, which is located further posteriorly relative to the posterior margin of the external naris than is the case in *N. haasi* and *N. marchicus*. A long narrow portion of the maxilla is exposed on the palate lateral to the palatine. The distinct ectopterygoid flanges are preserved on both sides, forming triangular projection with its medial apex pointing posteromedially and sharply turned downward. The posterior portion of the pterygoids including left and right quadrate rami, are well preserved. Two elements of the hyobranchial skeleton are preserved, the right one is located on the ventral surface of the pterygoid, and the left one near the left ectopterygoid flange.

The lower jaw is elongate and slender. Correlated with the short premaxillary rostrum, the mandibular symphysis is short and broad, with its ratio of length to width 0.96, much smaller than 1.46 in *N. jagisteus*. The mandibular symphysis bears 4 enlarged fangs, which are curved upwards, instead of being procumbent. The 1st, 2nd and 4th left dentary fangs are of approximately equal size, but the 4th fang has a slightly more sturdy tooth base. A small tooth is just erupting from the 3rd alveolus. On the right side the 1st fang is lost, the 3rd is the most slender, and the 4th the strongest. The dentary is narrow and long, extending along 69 % of the length of the lower jaw. Because of the tight contact of the lower jaw with skull, the dentary dentition remains obscure. But it is possible to ascertain that the dentary tooth row extends a little further posteriorly than the maxillary tooth row. The coronoid is a rather small bone located on the medial side of the jaw. It differs from all other species of *Nothosaurus* in forming a distinct coronoid process. The anterior end of the splenial appears to enter the mandibular symphysis. The jaw articulation is formed by the suprangular in its lateral part, and by the articular in its medial part. The retroarticular process is elongate.

Measurements　See Table 1.

表 1　杨氏幻龙(新种)头骨及下颌(IVPP V 13590)测量

Table 1　Measurements of skull and lower jaw of Nothosaurus youngi **sp. nov. (IVPP V 13590)**　(mm)

头骨长(吻端 - 枕髁) skull length from anterior end of snout to occipital condyle	160
吻端 - 外鼻孔前缘 length from anterior end of snout to anterior margin of external naris	29
吻端 - 眼眶前缘 length from anterior end of snout to anterior margin of orbit	55
吻端 - 上颞孔前缘 length from anterior end of snout to anterior margin of supratemporal fenestra	87
外鼻孔后缘 - 眼眶前缘 length from posterior margin of external naris to anterior margin of orbit	15
眼眶后缘 - 上颞孔前缘 length from posterior margin of orbit to anterior margin of supratemporal fenestra	7
眼眶后缘 - 头骨后端 length from posterior margin of orbit to posterior end of skull	71
头骨宽(上颌犬齿处) width of skull at the level of maxillary fangs	42
头骨宽(眶后部) width of skull at the level of postorbital region	58
头骨宽(鳞骨部) width of skull at the level of squamosal	81
外鼻孔(长 × 宽) size of external naris (length × width)	11 × 7
眼眶(长 × 宽) size of orbit (length × width)	27 × 19
上颞孔(长 × 宽) size of supratemporal fenestra (length × width)	55 × 19
下颌支长 length of mandibular ramus	186
下颌缝合部长 length of mandibular symphysis	24
下颌缝合部宽 width of mandibular symphysis	25

The postcranial skeleton is incompletely preserved. Within the vertebral column, the cervical and caudal vertebrae are preserved in articulation, two anterior dorsal vertebtae are exposed in lateral view, the other dorsal and the sacral vertebrae are obscured by overlapping elements and matrix. Two small triangular elements which meet each other along the midline represent the neural arch of the atlas, which are directly overlapping the anterior part of the 3rd cervical vertebra (Fig. 1). The neural arch of the axis is preserved in isolation lateral to the vertebral column, but the centrum of the axis can not be identified.

The $3^{rd}\sim 20^{th}$ cervical vertebrae expose their ventral surfaces, which are flattened, longer than wide, without lateral constriction, and without a distinct ventral ridge. The centra are platycoelous with a transversely widened elliptic contour as indicated by the 4th and 5th cervical centra. There is a short rib present on the 18th cervical vertebra, showing a stout proximal end and tapering gradually distally. Two articular facets are present separately on the neural arch and the centrum of the 19th cervical, indicating that the ribs of the posterior cervical vertebrae are double-headed.

The sacral vertebrae cannot be seen in the specimen IVPP V 13590, whereas two left sacral ribs are exposed as fairly prominent elements. They are relatively long elements (35mm), with a narrow proximal end and widened distal end (15mm × 8mm).

37 caudal vertebrae are preserved, exposed mostly in right lateral view. The caudal centra have no ventral sagittal ridge nor are they laterally constricted. The ribs on the anterior portion of the tail are relatively long, expanded in their middle region and tapering towards their distal ends. Many V-shaped and slender, rod-like gastralia are preserved, scattered in the region between the pectoral and pelvic girdles.

The pectoral girdle in V 13590 is in general similar to that of *Nothosaurus* (Romer, 1956 fig. 148A), but differs from the latter in some details. For example, the triangular interclavicle is relatively large, with its posterior border (36mm) longer then 1/2 of the anterior edge of the clavicle (70mm). The posterior stem of the interclavicle is absent, but it is difficult to ascertain whether it is lost or absent originally. Only the flattened ventral surfaces of the lower part of both scapulae are exposed. The left coracoid is similar to that of other *Nothosaurus* species (Romer, 1956 fig. 148A) in general shape, but it cannot be described because it is overlapped by some gastralia. Among the pelvic girdle two ilia and the right pubis are preserved. The ilium is small and low, but the pubis is a large plate-like element, with a concave anterior margin, a relative straight posterior margin, and a distinct obturator foramen.

The left anterior limb is preserved incompletely — the distal portion of the humerus is covered by gastralia and some phalangeals are lost. The humerus has a stout proximal end and a relative narrow diaphysis. The complete ulna and radius positioned originally resemble that of other *Nothosaurus*. The specimen V 13590 is different from other *Nothosaurus* species in having 4, rather than 3 elements in carpal region, which are intermedium, ulnare and two distal carpals.

Comparison and discussion The specimen V 13590 from the Zhuganpo Member of the Falang Formation of Xingyi, Guizhou is more similar to that of *Nothosaurus marchicus* than to other species of *Nothosaurus* in size, shape and proportions of skull. Both of them are small sized animal, with skull condylobasal length 160mm in V 13590 and less than 200mm in *N. marchicus*. Their skulls show relatively short and broad rostrum with rounded contours and a distinct rostral constriction. The skull ratios of V 13590 fit into the ranges of *N. marchicus* completely, as shown in Table 2. In addition, V 13590 shares a number of important characters with *N. marchicus*, such as nasals broad and leaf shaped, with radiating ornamentation, postfrontal with a distinct postorbital constriction, squamsal closely approaching the posterior end of the jugal, and so on. They distinguish each other in some respects. In V 13590 there are 4 small maxillary teeth in front of the maxillary fangs, rather than 5 as in *N. marchicus*. The ectopterygoid in V 13590 is general nothosaur shaped, but it tapers to a blunt tip anteriorly and reaches to about the level of the mid point of the palatine in *N. marchicus*. The specimen of V 13590 is different from all other species of *Nothosau-*

rus in having a distinct coronoid process and a splenial entering the mandibular symphysis region.

表 2　杨氏幻龙和 N. marchicus 头骨各部长度之比

Table 2　Skull proportions in N. youngi and N. marchicus

	N. youngi	*N. marchicus* *
吻端 - 外鼻孔/吻收缩部宽 snout-external naris / rostral constriction	1.4	1.1～1.4
吻端 - 眼眶/吻端 - 外鼻孔 snout-orbit / snout-external naris	1.9	1.8～2.0
吻端 - 上颞孔/吻端 - 外鼻孔 snout-upper temporal fossa / snout-external naris	3.0	2.9～3.4
外鼻孔长/外鼻孔宽 longitudinal diameter / transverse diameter of external naris	1.5	1.0～1.4 (1.6)

*from Rieppel et al., 1999 Table 1.

Two other nothosaur taxa- *Nothosaurus* sp. (Young, 1965; Rieppel, 1998) and *Lariosaurus xingyiensis* (Li et al., 2002) were also reported from Zhuganpo Member of the Falang Formation, Xingyi, Guizhou. The poorly preserved specimen of *Nothosaurus* sp. (NGMC Vm 1308) is different from V 13590 in having a wider postorbital arch and a more posteriorly positioned frontal-parietal suture. Although *Lariosaurus xingyiensis* has a typical lariosaur postcranial skeleton, but more nothosaur-like skull, it is distinguished from V 13590 in having a nasal excluded from the medial margin of the external naris, and a saggital crest behind the pineal foramen.

A data matrix including 25 characters of 11 taxa (Pachypleurosaurs, *Simosaurus*, *Germanosaurus* and 8 species of *Nothosaurus*) was analyzed cladisticly using the software package PAUP Version 3.1.1, and one single most parsimonious tree with a TL of 62 steps, CI of 0.667, and RI of 0.661 was obtained (Rieppel et al., 1999). When a new species of *Nothosaurus* (*N. jagisteus*) was included and two characters were modified in the cladistic analysis, one most pasimonious tree with TL of 65 steps, CI of 0.662, and RI of 0.651 was yielded (Rieppel, 2001). The monophyly of the genus of *Nothosaurus* was well founded by the analyses, but as pointed out by Rieppel (2001), there also continues to be a poor match of the hierarchy of nothosaurs to the stratigraphical distribution of the species of *Nothosaurus*.

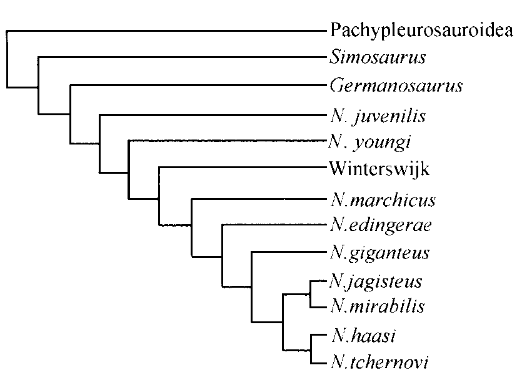


图 4　第 7 个最简约的树

Fig. 4　The 7th most parsimonious tree

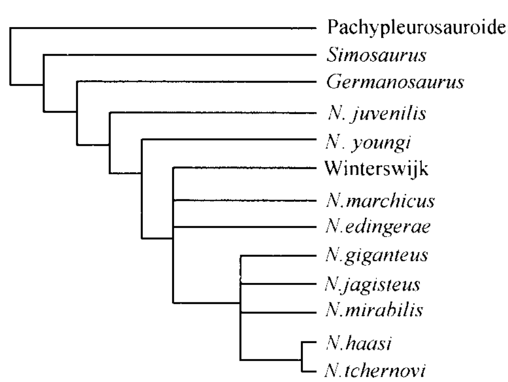


图 5　12 个最简约树的严格合意树

Fig. 5　The strict consensus tree

This time the data matrix (Rieppel, 2001 Appendix I) adding the characters of *N. youngi* (Table 3) is analyzed cladistically using PAUP Version 4.0b10. All multistate characters were treated as unordered and equally weighted, with pachypleurosaurs, *Simosaurus* and *Germanosaurus* as outgroups. Branch-and-bound search, ACCTRAN optimization yields 12 most parsimonious trees. The hierarchy of the taxa in the 7th tree is (pachypleurosaurs (*Simosaurus* (*Germanosaurus* (*N. juvenilis* (*N. youngi* (Winterswijk (*N. marchicus* (*N. edingerae* (*N. giganteus* ((*N. mirabilis*, *N. jagisteus*) (*N. haasi*, *N. tchernovi*))))))))) (Fig. 4). The clade of the monophiletic genus

Nothosaurus is supported by 4(1), 5(1), 19(1), 21(1), 22(2), 23(2), 24(1), same as that in the tree obtained by Rieppel in 2001. The synapomorphies for the clade (*N. youngi* (Winterswijk (*N. marchicus* (*N. edingerae* (*N. giganteus* ((*N. mirabilis*, *N. jagisteus*)(*N. haasi*, *N. tchernovi*)))))) are as follows: postfrontal remains excluded from upper temporal fossa 10(1), postorbital forms all anterior margin of the upper temporal fossa 12(1), anterior corner of upper temporal fossa constricted by distinct lateral convexity of parietal 18(1). In the strict consensus tree of 12 most parsimonious trees (Fig. 5), the relationship of (*N. giganteus*, *N. mirabilis*, (*N. haasi*, *N. tchernovi*), *N. jagisteus*), and the relationship of (*N. edingerae*, (*N. giganteus*, *N. mirabilis*, (*N. haasi*, *N. tchernovi*), *N. jagisteus*), *N. marchicus*, Winterswijk) remain unsolved. The phylogenetic analysis proves that *N. youngi* as an independent species is more primitive than all species of *Nothosaurus* but *N. juvenilis*.

表3 杨氏幻龙(新种)的性状(**矩阵和特征分析参见** Rieppel, 2001 Table 7 and appendix 1)

Table 3 Characters of *Nothosaurus youngi* **sp. nov**. (Data matrix and character analysis same as Table 7 and appendix 1 of Rieppel, 2001)

1(1)	2(1)	3(0)	4(1)	5(1)	6(?)	7(1)	8(1)	9(1)	10(1)
11(0)	12(1)	13(0)	14(1)	15(0)	16(1)	17(0)	18(1)	19(1)	20(1)
21(1)	22(2)	23(2)	24(1)	25(?)					

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